Protecting and Promoting Critical Technologies

Response to the Health and Agriculture Sector Discussion Papers

The University of Melbourne welcomes the opportunity to provide a response to the Department of Prime Minister and Cabinet's *Health and Agriculture Sector Discussion Papers*, as part of the Critical Technologies Policy Coordination Office's (CTPCO) stakeholder consultations on protecting and promoting Australia's 'critical technologies'. The University recognises the significant importance and potential impact of this process, particularly with reference to the Australian Government's broader legislative and policy program of protecting Australia's interests and building sovereign capacity. The University of Melbourne stands ready to engage and collaborate in this process, drawing on our experience as a comprehensive research institution.

The University acknowledges the dynamic and heightened external environment as a central driver of the Australian Government's emphasis on protecting critical technologies and domestic interests, and to this end, has been actively engaged in related policy consultations (such as on foreign interference at universities, and foreign arrangements). The University is also participating in the current consultation on commercialising university research, which, as the *Discussion Papers* all note, will contribute to the development and use of critical technologies.

The University recommends that the most effective protection and promotion of Australia's interests will come from investing in sovereign research capability and continued international collaboration. Globally leading research capability is only feasible if Australian researchers and industry maintain international partnerships and deep engagement to ensure timely access to technological advances and offshore markets.

Restricted outbound research engagement, or limits on the supply of specialist skilled researchers or technologists, will be detrimental to Australia's interests, as breakthroughs in many of the technologies listed in the *Discussion Papers* occur internationally. Protecting and augmenting Australia's research capability – across sectors and at points of technology convergence – will mean Australia is better positioned to quickly and effectively transfer breakthroughs and knowledge into industry applications and products.

In supporting the continuation of productive international research engagement on critical technologies, the University takes account of the Australian Government expertise that currently monitors and regulates research investments and higher-risk technologies where necessary and appropriate. These sites of expertise, located in defence and intelligence agencies, national research infrastructure and funding managers, and specialist areas in other departments are a ready resource for the Australian Government as it responds to critical technology developments over time.

The University's recommendations draw on this existing expertise, along with that in universities and industry, in proposing a standing advisory body to scrutinise and update future critical technologies lists, and guide the development of appropriately agile, de-compartmentalised and collaborative governance. Additionally, the Australian Government can support knowledge translation and commercialisation in various ways, such as through mission-driven investment, collaboration catalysts such as CRCs and linkage grants, and other innovation incentives.

This submission highlights potential for greater nuance and specificity in the categorisation of critical technologies. Dual use of technologies, which is noted in the CTPCO's *Protecting and Promoting Critical Technologies Paper*, adds complexity to determining which technologies require protection or action. The inclusion of both 'protection and promotion' as dual aims of this process adds a further challenge; research fields such as Artificial Intelligence can simultaneously underpin risk and opportunity, with applications ranging from military robotics to search and rescue. Input on how to best manage and/or promote the future direction of dual use technologies will be informed by the specific context of the technology application. The main body of this submission demonstrates this, providing illustrative feedback on the listed technologies, barriers, supply chain issues, and rates of uptake along with short case examples drawn from the University's experience of working on critical technologies.

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Recommendations

1. **Protecting and promoting:** The Australian Government should protect and promote Australia's interests with respect to critical technologies by investing in sovereign research capability and continued global research collaboration.

2. **Updating and interpreting the definition of critical technologies:** A standing advisory body – including the research sector, universities, industry and key government departments and agencies with relevant expertise – should be established to guide the CTPCO's annual review of the sectoral critical technology lists; analyse developments within and across technology areas; draw on cross-disciplinary and cross-sectoral expertise; and provide contemporaneous advice on evolving risks and opportunities for Australia.

3. **Governance of critical technologies**: The advisory body should assist the Australian Government, stakeholders and sectors to develop a shared consultation and governance model on critical technologies, with a central focus on the health and welfare of those impacted by the technologies.

4. **Oversight**: As governance of critical technologies must be agile and avoid technology compartmentalisation, it should be overseen by an entity suitably equipped to respond to technology convergence and rapid advancements in discovery and applications.

5. **Knowledge Transfer**: The Australian Government can crucially support transfer of research knowledge into products, such as through CRCs, linkage grants, direct contracts, and innovation vouchers for SMEs modelled on longstanding schemes in the US (Small Business Innovation Research, and Small Business Technology Transfer).

6. **Commercialisation:** To boost the commercialisation of critical technologies, the Australian Government should establish mission-based funding for research institutions and industries to develop technologies and applications reflective of national need, scale of benefit and Australia's competitive advantage.

7. **Supply chain issues**: Access to skilled specialists and graduate researchers from overseas should be viewed as an important supply chain issue that impacts Australia's long-term sovereign capability.

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1. **What are the priority critical technologies, current and emerging, in this sector over the next 10 years? Are these reflected in the list provided in the discussion paper?**

Regarding the critical technologies listed in the *Health/Agriculture Sector Discussion Papers*:

While capturing existing areas of strength in Australia, the categories included in both the Health and Agriculture lists are broad and high-level. The absence of further information on the intended implementation and impact of the two lists limits commentary on the risks (appropriateness for protection) and opportunities (imperatives for investment) pertinent to each category.

To illustrate the importance of the commentary and recommendations we provide relating to Q6 (advisory, horizon scanning, governance) and to highlight the need for a more granular, contextualised and agile approach to identifying critical technologies, the following examples are given:

- In the Agriculture critical list, the first item is "AI Planning". This is indeed an active and important sub-area in AI research in Australia and globally, with tens of thousands of academic publications released over 2020-2021. It is also a high-level category covering diverse research applications of the field, with the same fundamental technology both invaluable for commercial application and generation of economic and societal value and also key to sensitive defence applications.
- In the Agricultural list, "GPS jamming resistant PNT" is included. This is a highly classified and crucial area of work conducted by Australian defence agencies, and similarly widely researched around the globe. It serves Australia's interests to ensure defence agencies continue have key researchers in Australia engaged in this work and closely connected to advancements in technology. However, in practice, this category is quite distinct from GPS issues and applications in agriculture. It would not serve

Australia's interests to prohibit commercial PNT or GPS products relevant to Australian agriculture that do not overlap with defence military capabilities.

- In the Agriculture list, "Biocomposites" are given as a critical technology. This high-level category similarly requires a nuanced treatment: Biocomposites in agriculture should be open research internationally, while Biocomposites in defence should be considered by Defence Science and Technology Group (DSTG) because of the possible application to stealth materials.
- In the Health list, "Synthetic Biology" is a category inclusion. While there are known risks attached to certain areas of research involving biological agents, and potentially a need for monitoring, Synthetic Biology as described in the list has a great diversity of applications that can be used for legitimate and illegitimate ends. In this area of technology, significant breakthroughs tend to occur outside of Australian research, highlighting the need to remain meaningfully and contemporaneously connected to new information through research links.

Recommendation 1 - Protecting and promoting: The Australian Government should protect and promote Australia's interests with respect to critical technologies by investing in sovereign research capability and continued global research collaboration.

As a further observation on the challenges of technology categorisation and framing for a policy purpose, the University notes that the next generation of technological innovation will likely come from the *convergence* of these technologies. For example:

- Biorobotics and similar technologies should be anticipated to break down the barriers between machine and human, as cell engineering allows biologics to take on programmable functions. In this way, stem cell derived tissue implants that interface with technologies to address spinal injury, epilepsy, vision or hearing loss are potential medical applications.
- "Precision Medicine" will increasingly include stem-cell avatars of tissues to model individual prognosis, drug responses or to design personalised therapies. (The current and future applications of stem cell science are clearly captured in the Australian Government's Medical Research Future Fund's Stem Cell Therapies Mission - National Consultation on the Roadmap and Implementation Plan).
- "Medical Countermeasures" and "Precision Medicines", both categories in the Health Discussion Paper, will require other critical technologies, platforms and inputs, such as upgrades to the Australian Synchrotron and advanced cryo-electron microscopy and cryo-tomography. Precision Medicines will also require computing solutions for early-stage drug discovery and development (from target validation through to preclinical testing); investment in high-throughput drug discovery pipelines; mass spectrometry platforms; nuclear magnetic resonance spectrometry; and mRNA and DNA-based treatments.
- While the technology related to stem cells is framed within a subsection of "Gene Technology" in the Agriculture list, this does not account for the source of the cells nor the devices that may be needed to sustain them. Regenerative (stem cell)

medicine may evolve to deliver personalised therapies via inclusion of domains from "Synthetic Biology".

- New generation "Diagnostics" will include biologic components, such as devices, including the implantable, miniature pancreatic bioreactor that delivers on-demand insulin by real-time sensing of glucose levels.
- "Fertiliser technologies" that utilise novel chemistry or biological (waste or microbial) approaches will be increasingly important to increase nitrogen uptake and reduce nitrogen pollution in Australian agricultural practice.

The above are examples of rapidly evolving fields that could address Australian challenges, such as the need for remote medical diagnosis; monitoring of infectious disease spread; and improved autonomous patient monitoring for chronic diseases in rural communities. Australia's interests will not be served by establishing policy and regulations that do not recognise, or cannot respond to, the evolution and convergence of these technologies over time. Even today, regulatory, legal and societal expectations of technology are not adequately framed at the points of convergence. As such, any new regulation or Australian regulator of critical technologies will need to be equipped to ensure these frontier technologies attract agile and responsive oversight or regulation.

The experience of trying to rapidly develop COVID-19 treatments in Australia highlighted other issues relating to resourcing and research infrastructure. Australian research ecosystem requires long-term funding to maintain critical expertise at critical mass. Australian high-end platform technologies need to constantly maintain and upgrade performance to stay at the cutting-edge. Any new technologies and capabilities identified as Australian priorities will require substantial investment.

Recommendation 2 - Updating and interpreting the definition of critical technologies: A standing advisory body – including the research sector, universities, industry and key government departments and agencies with relevant expertise – should be established to guide the CTPCO's annual review of the sectoral critical technology lists; analyse developments within and across technology areas; draw on cross-disciplinary and cross-sectoral expertise; and provide contemporaneous advice on evolving risks and opportunities for Australia.

2. Have you identified or experienced any supply chain issues associated with critical technologies?

Australia faces supply chain issues that currently, or could potentially, disadvantage the research and development of critical technologies within Australia. An important supply chain issue is access to specialists and an assured pipeline of research/technological capability, as demonstrated in the following examples:

- During the COVID-19 lockdowns in 2020, many high-end research platforms across Australia experienced significant and expensive setbacks in capability, due to the inability of skilled specialist engineers to enter Australia to install, calibrate and maintain the technology infrastructure. Research infrastructure of this level is highly specialist equipment and sourced from world-leading overseas suppliers. For new

instruments, the installation is a skilled operation and requires factory-trained qualified engineers to ensure the equipment is installed, calibrated and operating within the required specifications. The experience demonstrates how exposed Australia's research system is to future supply cuts of specialist skills - in this case detrimentally impacting for many months the operation of critical Australian research infrastructure valued at more than $100 million.

- The future supply of capability is demonstrably a significant issue for Australia when looking at the demographics of PhD candidates. Graduate Researchers from overseas represent a sizeable and important part of Australia's research ecosystem and long-term capability. For example, at University of Melbourne, international Graduate Researchers are 41% of the cohort in STEM faculties, a proportion we anticipate is similar to the national figure. Broken down into disciplines relevant to the Health and Agriculture critical technologies, our international Graduate Researchers are 67% (Agriculture and Food); 55% (Microbiology and Immunology); 72% (Mechanical Engineering); 67% (Electrical and Electronic Engineering). The University cautions against policy interventions that overly restrict pathways to Australia's research training system.

Recommendation 7 - Supply chain issues: Access to skilled specialists and graduate researchers from overseas should be viewed as an important supply chain issue that impacts Australia's long-term sovereign capability.

It will be important to maintain, as the *Protecting and Promoting Critical Technologies Paper* noted, 'enduring access to the supply of diverse and secure critical technologies.' Many critical technologies will not feasibly emerge in, or be led by, Australia, but will nevertheless be critical to our national interests and future technology mix. For instance:

- "Global Navigation Satellite System (GNSS) augmentation" is included in the Agriculture list, with standard systems and products likely to be developed overseas. Open access to this technology and global markets will ensure Australia can draw on the latest smart city technology to support future transport, logistics, infrastructure and more.
- Similarly, "Cube-sats" technology, included in the Agriculture list, is a potentially sensitive technology that is currently driven by other nations. Accordingly, a deeply engaged Australian research capability should be invested in this technology to ensure Australia can have uninterrupted beneficial access to develop and transfer Cube-sat technology for domestic commercial and industrial applications.

3. **How fast are critical technologies taken up in this sector? What are the barriers to uptake?**

In Agriculture, uptake of critical technologies can be relatively slow, whereas, in Health, uptake is often rapid. These differences largely reflect the relative investment levels. Barriers exist in both sectors, including:

- Lack of incentives for industry to adopt new technologies.
- Lack of knowledge across sectors about new technologies.
- Lack of consumer awareness and acceptance of new approaches.
- Prohibitive costs of moving to new technologies.
- Lack of expertise and critical mass for development of new technologies (as discussed in the previous section).
- Lack of adequate infrastructure, planning, coordination and support.

Regarding the above (third) point on consumer awareness and acceptance, investment and focus should be directed towards public education about priority critical technologies. Often the carriage of public discourse on new technologies is left to individual research groups without considered and inclusive engagement with end-users. These fields are evolving rapidly and the input of the community, particularly patients, should be deliberately placed at the centre of focus as the fields evolve. A lack of public engagement and explanation in the past has resulted in degrees of community mistrust about GMO foods, vaccine hesitancy, and suspicions about frontier technologies.

As an illustration of the above (final) point about adequate infrastructure, Australian researchers have led the development of in-vitro disease modelling using patient-derived stem cell lines. However, Australia lacks a consolidated registry of these lines and clarity around access. This means Australia runs the risk of missed opportunities to advance research into precision medicines and other applications. Individual research groups hold valuable resources that could potentially forge greater global and national research collaborations and industry partnerships. There is also the risk of a duplication of endeavour, in a limited and contested funding domestic pool, rather than maximising and building on Australia's existing resources and collective knowledge.

4. **Which critical technologies present the best opportunity for commercialisation in Australia?**

Currently, there are significant opportunities for commercialisation in high throughput drug discovery; disease diagnostics; and medical devices. Over time, changes in the external environment, changes in capability and knowledge, and the changing needs of the Australian and global community will influence which technologies should be prioritised for commercialisation.

Building the soft and hard research infrastructure for discovery and translation are key elements of a translation and commercialisation ecosystem that is sustainable and responsive. Improving Australia's innovation and research commercialisation performance will require a sophisticated gap analysis of the skills, capabilities and infrastructure required to deliver on that aspiration. Often, these professional skills typically lie outside the academy and are in short supply in Australia. Building specialised skills capability in Australia will be part of the solution to improving commercialisation outcomes. Further, finetuning and better promoting existing programs, such as PhD industry intern programs, will help to build stronger connections between industry and universities, facilitating greater knowledge transfer.

The University recently submitted a response to the Department of Education, Skills and Employment's *University Research Commercialisation Consultation Paper*, which supported the Australian Government adopting a mission-based approach to stimulate research commercialisation. A similar approach to identify and invest in critical technologies could enable a strategic and flexible way of leveraging Australia's strengths and capabilities.

Recommendation 6 - Commercialisation: To boost the commercialisation of critical technologies, the Australian Government should establish mission-based funding for research institutions and industries to develop technologies and applications reflective of national need, scale of benefit and Australia's competitive advantage.

5. What will happen if we do not adopt critical technologies in this sector?

A lack of critical technology and supportive infrastructure in Australia means the commercialisation of technologies will occur overseas. This situation played out with the pandemic, demonstrated by the limited ability to develop and manufacture COVID-19 vaccines in Australia. Manufacturing of vaccines, drugs, diagnostics and devices require the training of a highly skilled workforce with expertise in using high-end infrastructure. Addressing known gaps in research infrastructure will be necessary if Australia is to build sovereign capability in this field.

However, Australia will not be able to domestically generate all the critical technologies it needs. For that reason, ongoing international engagement is crucial. Restrictions on research areas or certain collaborations, imposed with the intention of protecting Australian interests, carry the risk of damaging Australia's interests over the longer term. Policy controls or regulation of technology, unless designed appropriately, may quickly become outdated. Overly robust restrictions on international collaboration could mean Australian researchers cannot directly participate in leading research but can only rely on open or published research, giving companies in other countries a two-year advantage on the commercialisation timeline.

In the Agricultural sector, Australia's food production needs to expand and sustain its high quality. This will certainly require critical technologies to be developed and to be adopted. With climate change escalating and less arable land available, the challenge of increasing productivity while reducing resource input will only be met through the adoption of new critical technologies.

In the Health sector, failure to adopt critical technologies will mean missed opportunities for research discovery, industry and ordinary Australians who have unmet health needs. Australia's large landmass, coupled with a concentration of industry, health and medical services in and around capital cities, poses challenges for delivering (and accessing) optimal healthcare. New technologies have the capacity to address these challenges. For instance, new generation diagnostics will enhance precision medicine, allowing remote monitoring and adjustments of medicines whether the patient is in Melbourne, Brisbane or Birdsville.

6. **What impact do you think critical technologies will have in the future in this sector? For example, on national security, economic prosperity and social cohesion (in medical - e.g. ethical or moral considerations).**

The adoption of critical technologies will influence Australia's future in many interdependent ways. For instance, national security is shaped by global food security and our role as a top food producer. Any emerging sovereign vulnerability is likely to have negative flow-on effects that will impact the economy and social cohesion.

The adoption of critical technologies, or failure to do so, will also influence whether Australia is able to service the health needs of communities and health systems in rural and remote places. Critical technologies in Australia are likely to be part of the solutions for many entrenched, unique challenges facing Australia, underpinned by our geography, climate, population spread and diversity.

7. **How should government, industry, academia and end users work together to assess the impact of critical technologies in Australia?**

It will be important for key stakeholders – government, industry, academia, SMEs and other end users – to work together to assess the impact and advise on future directions of critical technologies. To some degree this already occurs through existing processes – through the National Collaborative Research Infrastructure Strategy and entities such as the Grains Research Development Corporation – but such arrangements should become more encompassing across technologies.

Advisory and horizon-scanning:

Australia's adoption and management of critical technologies will need to keep pace with technological advances, social and environmental requirements, and emerging risks and opportunities. Rather than establishing a new regulatory function, the Australian Government can be better positioned to promote or protect critical technologies by increasing the reach and coordination of existing agencies with the addition of expert advice from research and industry/commercial sectors.

To provide an expert horizon-scanning input, a standing advisory body that includes the research sector, universities, industry and key government agencies should be established and resourced to analyse developments in each technology area, draw on cross-disciplinary expertise and provide advice to decision-makers on evolving risks and Australia's capacity to adapt and prepare for the future.

The advisory body should link with the Department of Prime Minister and Cabinet/CTPCO's whole-of-government strategic remit, and involve as key participants from government agencies that already manage research infrastructure and sovereign risk, including (as examples): the Department of Education Skills and Employment (which manages investment under the National Collaborative Research Infrastructure Strategy); Defence (the DSTG and Defence Industry Security Program); ASIO; Department of Home Affairs (which hosts the University Foreign Interference Taskforce, and the National Counter Foreign Interference Coordinator); the Australian Chief Scientist; the ARC and CSIRO.

These government agencies and offices already provide policy leadership and regulation of higher risk technologies or are holders of relevant intelligence and expertise on potential risk. Collaboratively with university and industry representatives, such an advisory body will be well-placed to guide the coherent and co-ordinated evolution and impact of the sectoral critical technology lists.

Recommendation 2 - Updating and interpreting the definition of critical technologies: A standing advisory body – including the research sector, universities, industry and key government departments and agencies with relevant expertise – should be established to guide the CTPCO's annual review of the sectoral critical technology lists; analyse developments within and across technology areas; draw on cross-disciplinary and cross-sectoral expertise; and provide contemporaneous advice on evolving risks and opportunities for Australia.

Governance:

Relevant sectors in Australia should adopt a shared consultation and governance model that places those whose health and welfare will benefit from technological advances at the front and centre of strategy development and impact assessment.

Governance of critical technology should be agile and responsive, particularly with regard to establishing responsible research and innovation frameworks. While genetic testing and privacy are key focuses of current regulation, the critical technologies listed in the *Discussion Paper* will require a broader positioning. The blurring of categories between critical technologies will be an issue in regulation; regulatory compartmentalisation of 'device/gene/cell' is outdated and could be flagged as a risk for clinical or commercial application of engineered cells. In this vein, governance and regulation should avoid technology compartmentalisation and should be overseen by a regulator that is suitably resourced to respond to converging technologies and rapid advancements in technology applications.

Recommendation 3 - Governance of critical technologies: The advisory body should assist the Australian Government, stakeholders and sectors to develop a shared consultation and governance model on critical technologies, with a central focus on the health and welfare of those impacted by the technologies.

Recommendation 4 – Oversight: As governance of critical technologies must be agile and avoid technology compartmentalisation, it should be overseen by an entity suitably equipped to respond to technology convergence and rapid advancements in discovery and applications.

Incentives to business to boost research commercialisation impact:

The Australian Government can significantly influence the success of critical technologies in Australia by supporting the transfer of research knowledge into products. This can be achieved through valuable existing mechanisms such as CRCs, Linkage grants and direct contracts, as well as provision of incentives to industry and small and medium enterprises (SMEs) to engage with research. The Australian Government can influence demand – for instance, incentivising farmers or food producers to adopt a particular critical technology would boost the economic impact of local technologies.

Given the dominance of SMEs in Australia's economy, SMEs could be provided with innovation vouchers to engage with research providers, in a program potentially similar to the decades-old, and successful, Small Business Innovation Research and Small Business Technology Transfer programs run by the US National Science Foundation. DSTG have recently started a similar scheme, which could be effective in other technology sectors. Government policy in relation to RSP calculation has been used to alter perceptions in relation to Category 2-4 research income and incentives could be provided to business, of all sizes, to engage with universities.

Recommendation 5 - Knowledge Transfer: The Australian Government can crucially support transfer of research knowledge into products, such as through CRCs, linkage grants, direct contracts, and innovation vouchers for SMEs modelled on longstanding schemes in the US (Small Business Innovation Research, and Small Business Technology Transfer).

Recommendation 6 - Commercialisation: To boost the commercialisation of critical technologies, the Australian Government should establish mission-based funding for research institutions and industries to develop technologies and applications reflective of national need, scale of benefit and Australia's competitive advantage.

8. What opportunities and risks do you see from biotechnology and/or photonics?

Photonics is crucial for sensor technologies, which will be the future of agricultural technologies. Biotechnology capability will be crucial to Australia, linked with other technologies as listed in the *Discussion Papers*. It will be important to engage the Australian public as the technologies and applications advance, by providing education about new technologies, building familiarity and acceptance.

In both domains opportunities and risk factors include: encouraging closer interactions between industry and academia (such as co-location and sharing of resources); the dearth of industry trained CEOs, COOs and project managers; and limited investment funds for high-risk, early-stage developments.